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Demo: A Low-Cost Fleet Monitoring System

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Abstract
Organizations use fleet monitoring systems for e.g., vehicle tracking, driver behavior analysis, and efficient fleet management. Current systems are designed for commercial use and are of high cost. We present a prototype of a low-cost fleet monitoring system that could be used for non-commercial applications. The system is composed of a device, a service application, and a Web application. The device reads data such as speed and fuel from the internal network of the connected vehicle and the location of the vehicle and sends them to a remote service. The remote service processes and stores the data. The users use a Web application to view the data about their vehicles in real-time.

Keywords
Fleet Management System, Intelligent Transportation System, Internet of Things

Disciplines
Electrical and Computer Engineering | Systems and Communications | Systems Architecture

Comments
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***Abstract*—Organizations use fleet monitoring systems for e.g., vehicle tracking, driver behavior analysis, and efficient fleet management. Current systems are designed for commercial use and are of high cost. We present a prototype of a low-cost fleet monitoring system that could be used for non-commercial applications. The system is composed of a device, a service application, and a Web application. The device reads data such as speed and fuel from the internal network of the connected vehicle and the location of the vehicle and sends them to a remote service. The remote service processes and stores the data. The users use a Web application to view the data about their vehicles in real-time.**

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I. Introduction

Fleet Management Systems (FMSs) are commonly used by companies to manage their vehicles and drivers. The fleet management market is expected to grow from USD 13.78 Billion in 2017 to USD 28.66 Billion by 2022 [1]. FMSs [2] tend to collect the locations of the vehicles, which allows to monitor the vehicles.

FMSs are widely used. In many systems, such as CollectiveFleet,[1] ManagerPlus,[2] and OnFleet,[3] the driver enters manually the data using a mobile application and the system uses the device's GPS to locate the vehicles. The fleet manager and drivers interact with the application for e.g., messaging and dispatching.

Each vehicle uses a set of sensors and Electronic Control Units (ECUs) to collect data about the vehicle's behavior and environment, and to control the functionalities of the vehicle. The ECUs collaborate by exchanging messages, such as the speed, the RPM, and the fuel level through the in-vehicle network as depicted by Figure 1 [3]. Few FMSs collect these in-vehicle data in addition to vehicle location data. These include FleetComplete,[4] Fleetmatics Now,[5] and High Point GPS.[6] These solutions are expensive, sold as a service, and use data of only limited number of ECUs.

The main goal of the project is to develop a FMS that collects in-vehicle data and vehicle's location such that users can access the data using a Web application. In addition, the cost of the devices used by the system should be affordable for personal use.

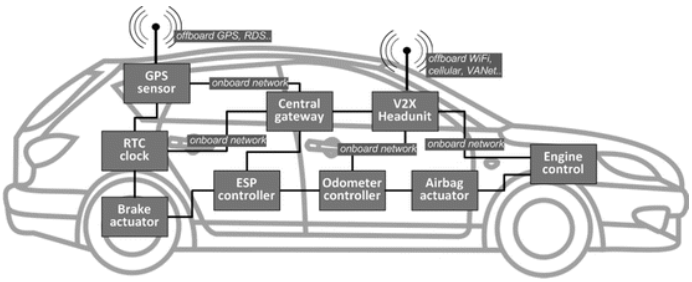

Fig. 1. Example of architecture of in-vehicle network [3].

The following sections describe the architecture of the system, the demonstration of the system, and the system setup; and concludes the paper.

II. System Architecture

The main functional requirements of the system are:

- The system shall collect data through the vehicle's On-Board Diagnostics II (OBD-II) port.[7]
- The system shall transmit data from the vehicle to the server.
- The system shall transform the raw in-vehicle data to data that human can understand on the server.
- The system shall record vehicle data into a database.
- The system shall display a map with the locations of all the vehicles in the fleet.
- The system shall display live data, such as speed, engine temperature of a given vehicle.
- The system shall allow managers to register or remove the vehicles that belong to a particular fleet,
- The system shall allow managers to customize the data being displayed to them.

The main non-functional requirements are: allow only managers to view fleet data on the website, allow only managers to view vehicles in their fleet, and use Node.js for the server components.

Figure 2 shows the software architecture of the system. The system is composed of four components: the Fleet Data Collector, the Fleet Management Service, the Fleet Management Database, and the Fleet Management Web Application.

[1]https://collectivedata.com/solutions/collectivefleet/
[2]www.managerplus.com
[3]https://onfleet.com/
[4]https://www.fleetcomplete.com/en/
[5]https://us.fleetmatics.com/login.aspx
[6]High Point GPS

[7]Standardized system that on-board computers in cars and trucks use for self-diagnostics and reporting.

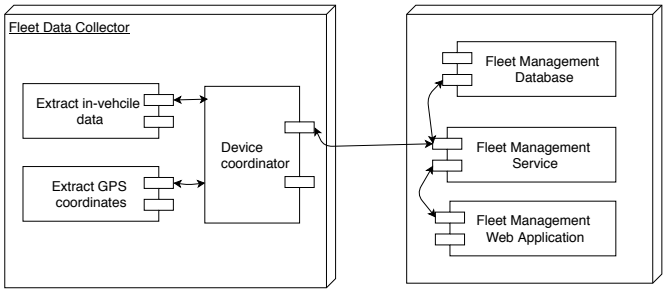

Fig. 2. Architecture of the system.

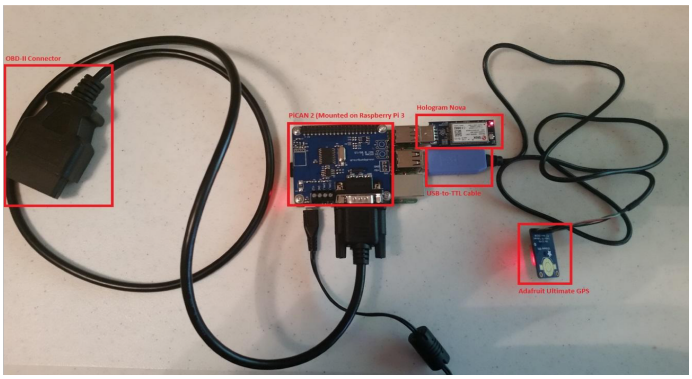

Fig. 3. Parts of the system.

TABLE I
LIST OF PARTS USED IN THE FLEET MANAGEMENT SYSTEM.

No	Part	Description	Price
1	Raspbery PI 3	Runs the Fleet Data Collector component	$69.99
2	PICAN2	Communicates with the vehicleś CAN-bus	$48.95
3	OBD-II - DB9 cable	Connects the PICAN 2 to the vehicleś OBD-II	$10.09
4	Adafruit Ultimate GPS	Gets the current position	$39.95
5	Hologram Nova	Communicates the PI and the server through the cellular network.	$54.00

Fig. 4. Example of architecture of in-vehicle network.

The Fleet Data Collector includes components that initiates the devices and services for extracting data from the in-vehicle network of the connected vehicle and the position of the vehicle. The Fleet Data Collector sends the data to the Fleet Management Service, which stores them in the Fleet Management Database. The Fleet Management Web Application visualizes the fleet management data it gets from the Fleet Management Service to the user.

The Fleet Data Collector is implemented using Python and runs on Raspeian operating system[8]. The Fleet Management Service runs on Node.js [9], the Fleet Management Database is managed by MangoDB [10], and the Fleet Management Web Application uses AngularJS framework [11]

Table I lists the parts that we used to implement the system. The total of the parts is as low-as $200. Companies charge either a flat fee of about $10.000 or per unit fee composed of 100$ to 600$ for the tracking devices and $10 to $30 for the monthly usage fees [4]. Figure 3 shows the parts that we used for the Fleet Data Collector component. The components come with easy to use libraries.

The source code of the software is available at [5].

III. DEMONSTRATION

Figure 4 shows the user interface of the prototype. The user can use the interface to view the location of a given vehicle on Google map and see the change of the speed of the vehicle. The user could configure the system to collect to in-vehicle data that they are interested to monitor such as the level of fuel and RPM.

A recording of live test is available in YouTube [6]. The recording is made using Ford mini-van in Iowa State University, Ames, IA on April 22, 2018.

IV. CONCLUSION

This demo paper describes a prototype of a low-cost fleet management system that could be used for non-commercial applications.

[8]https://www.raspberrypi.org/learning/hardware-guide/quickstart/
[9]https://nodejs.org/en/
[10]https://www.mongodb.com/
[11]https://angularjs.org/

REFERENCES

[1] "Fleet management market worth 28.66 billion usd by 2022." https://www.marketsandmarkets.com/PressReleases/fleet-management-systems.asp. accessed on May 2018.
[2] "Fleet management software." https://www.softwareadvice.com/fleet-management/?deployment_id=&market_products_sort_order=ASC&market_products_sortby=price_range_low&more=true&price_ranges=&stars=&segment_id=&platforms=&int_site_code=&size_id=. accessed on May 2018.
[3] L. ben Othmaneand H. Weffers, M. M. Murtadha, and M. Wolf, "A survey of security and privacy in connected vehicles," in *Wireless Sensor and Mobile Ad-Hoc Networks: Vehicular and Space Applications* (D. Benhaddou and A. Al-Fuqaha, eds.), pp. 217–247, New York, NY: Springer New York, 2015.
[4] "What does fleet management software cost?." https://blog.capterra.com/what-does-fleet-management-software-cost/. accessed on August 2018.
[5] "Fleet monitoring system - source code." https://github.com/lbenothmane/FleetManagement/. accessed on May 2018.
[6] "Fleet monitoring system." https://www.youtube.com/watch?v=cDxIMVuyK1E&feature=youtu.be. accessed on May 2018.